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TOLEDO
AIR POLLUTANT EMISSION
INVENTORY

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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TOLEDO AIR POLLUTANT EMISSION INVENTORY

Prepared by

David V. Mason

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
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Emissions of five pollutants (SO_x, Particulates, CO, Hydrocarbons, and NO_x) are estimated for 1967. Summaries of the estimates are tabulated for each pollutant by subcategories within four source categories: transportation, combustion of fuels by stationary sources; refuse disposal; and industrial process emissions. Detailed estimates by category, and by a grid coordinate system are presented. For each pollutant five densities of emission are plotted on a grid of the area.

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PREFACE

This report, which presents the emission inventory of the Toledo, Ohio metropolitan area, is another in a series of studies outlining the sources and emissions of air pollutants for major metropolitan areas in the country. These reports provide estimates of total emissions of oxides of sulfur, oxides of nitrogen, hydrocarbons, carbon monoxide and particulate matter The emissions of these pollutants are delineated with respect to source type, season of the year as well as their geographical distribution within the area. These surveys are also intended to determine the present level of emissions and status of their control.

The general procedure for these surveys is based on the rapid survey technique.[1] The Study Area is divided into grid zones that serve as the basis for locating sources and reporting their emissions. All sources of pollutants are divided into two subgroups - point and area sources. Sources that emit large quantities of air pollutants are considered individually and located specifically within the area. This latter group which generally contains about fifty to one hundred sources typically includes large industries, power plants, and central refuse burning facilities. The remaining multitude of sources are considered collectively as area source and their emissions are reported as totals for grid zones. This category includes motor vehicles, home heating, smaller industries, on-site refuse burning, etc. The emissions in both cases are expressed in terms of tons of pollutants for an average annual, summer, and winter day.

Emissions for the most part are estimated using various indicators of pollutant emissions and average emission factors that are related to these.

This means that information and data are collected on fuel consumption, refuse burning rates, vehicle miles and gasoline consumption, as well as various production data. These are then translated into emission estimates by use of average emission factors.[2] These factors, for the most part, represent average emission rates for a particular industry or fuel type.

INTRODUCTION

The information and data presented in this report were gathered in cooperation with the acknowledged local agency during a survey conducted in January, 1969. The data obtained in this study is for the most part, representative of 1967 and emission estimates presented herein should be considered as showing the conditions during 1967

For purposes of this survey, the Study Area consists of five counties surrounding the city of Toledo, Ohio. The entire area covers some 2,200 square miles and includes a 1967 population of about 700,000 people. The Study Area is subdivided into 49 grid zones ranging in size from 25 square kilometers in the heavily populated areas to 400 square kilometers in the outlying areas.

Any individual source which had emissions significant to the overall pollution was classified as a point source and located specifically in the aforementioned grid zones.

The remaining single sources were added to the area sources and reported as grid totals.

Because of the inherent difference in type of equipment, operating rates, control equipment, and efficiency of operation among the plants and fuel users within a given category, the application of the emission factors to any individual plant or even a smaller number of similar plants or processes may result in a discrepancy between the actual and the estimated emissions. However, the estimates of total pollutants from all sources in the study area should be reasonably accurate since the emission factors are based on average conditions.

SUMMARY OF RESULTS

As estimated 700 thousand tons of the five pollutants are emitted annually in the Study Area. The breakdown of these emissions by type of pollutant and source category are summarized in Table 1. The following is a brief summary of pollutant emissions as presented in Table 1.

Sulfur Oxides	1967 Total - 193,000 Tons	
	Steam-Electric	64%
	Industrial Fuel	22
	Industrial Process	9%
	Other	5%
Particulates	1967 Total - 87,000 Tons	
	Industrial Process	45%
	Industrial Fuel	27%
	Steam-Electric	18%
	Other	10%
Carbon Monoxide	1967 Total - 300,000 Tons	
	Road Vehicles	78%
	Industrial Process	14%
	Refuse Disposal	5%
	Other	3%
Hydrocarbons	1967 Total - 77,000 Tons	
	Industrial Process	56%
	Road Vehicles	39%
	Other	5%

Nitrogen Oxides	1967 Total - 65,000 Tons	
	Steam-Electric	38%
	Industrial Fuel	25%
	Road Vehicles	21%
	Industrial Process	6%
	Residential Fuel	4%
	Refuse Disposal	3%
	Other	3%

EMISSIONS BY POINT SOURCES

Oxides of Sulfur	97%
Particulates	99%
Carbon Monoxide	17%
Hydrocarbons	57%
Oxides of Nitrogen	63%

TABLE 1 SUMMARY OF AIR POLLUTANT EMISSIONS FOR THE TOLEDO-MONROE STUDY AREA, 1967 (TONS/YEAR)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbon	Nitrogen Oxides
Transportation	1,700	2,200	237,800	31,300	14,000
Road Vehicles	1,100	2,000	233,700	18,700	13,600
Evaportation				11,700	
Other	600	200	4,100	900	400
Combustion of Fuels by Stationary Sources	195,900	42,500	4,800	1,900	49,800
Industry	64,600	23,800	1,000	900	20,700
Steam-Electric	123,400	16,000	600	300	24,600
Residential	5,200	1,400	2,100	500	2,900
Commercial	2,700	1,300	1,100	200	1,600
Refuse Disposal	100	2,900	15,100	900	1,900
Incineration	100	300	1,100	Neg.	100
Open Burning		2,600	14,000	900	1,800
Industrial Process Emissions	16,900	39,400	42,900	43,800	3,800
TOTAL EMISSIONS	214,600	87,000	300,600	77,900	69,500

STUDY AREA

The Study Area for the emission survey of the Toledo Metropolitan Area consists of five counties - Lucas, Ottawa, Sandusky, Wood and Monroe. The first four counties are located in the northern part of Ohio, while Monroe County is in the southeastern section of Michigan. Figure 1. shows the location of the Toledo Study Area relative to other cities in its vicinity. Figure 2. represents a more detailed drawing of the Study Area.

The heaviest concentrations of industry in the Study Area are located along the Maumee River which runs through Toledo and in the City of Monroe. The manufacturing industries (Table 3) in the Study Area are orientated toward the production of glass, automobiles and chemical products.

Although the total area is slightly over 1800 square miles, only some 140 square miles are at present urbanized. About 70 percent of the Study Area's 700,000 people reside in Lucas County. The 1960 and 1967 (est.) population of each county are presented in Table 2. Comparison of the 1960 and 1967 population for the entire country shows an increase of 10.9 percent, where as the Toledo Study Area increased by approximately 7.9 percent in the same period.

Figure 1. Map of the Toledo study area and surrounding states.

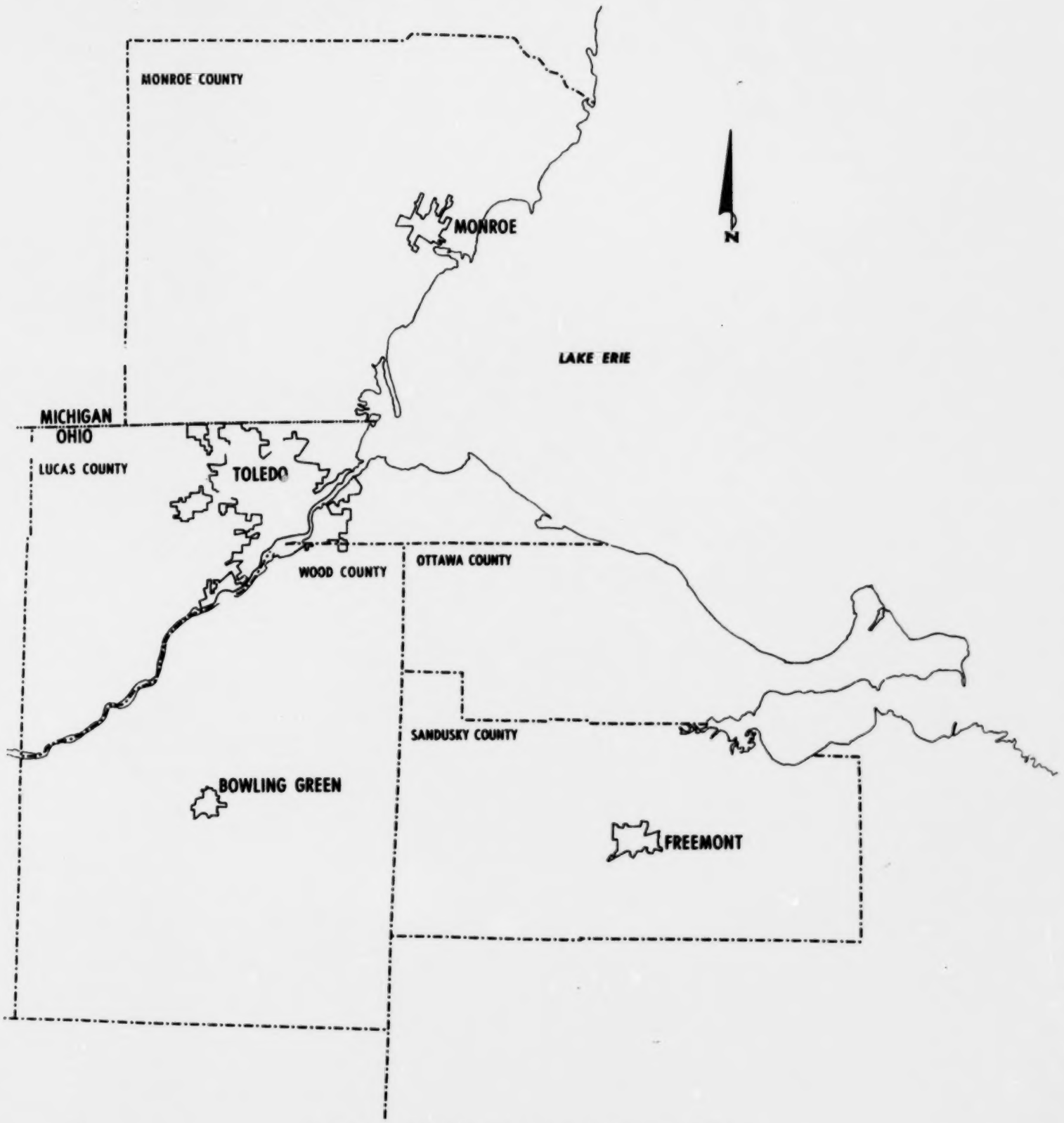

Figure 2. Detailed map of the Toledo study area.

TABLE 2. POPULATION FIGURES FOR THE TOLEDO-MONORE STUDY AREA

	1960	1967	Percent Increase
Lucas County	456,931	488,206	6.8
Ottawa County	35,323	38,403	8.7
Sandusky County	56,486	62,430	10.5
Wood County	72,596	80,889	11.4
Monroe County	31,159	34,087	9.4
TOTAL	652,495	704,015	7.9

TABLE 3. NUMBER OF INDUSTRIAL ESTABLISHMENTS IN STUDY AREA BY COUNTY, 1960

	Lucas County	Ottawa County	Sandusky County	Wood County	Monroe County
Food and Tobacco	37	3	7	7	1
Textiles	9	-	2	-	1
Paper & Printing	26	2	3	1	12
Chemicals	25	3	3	5	2
Lumber & Wood	13	2	-	1	2
Stone & Gravel	13	5	6	3	3
Primary & Intermediate Metals	56	4	11	7	11
Electrical Machinery	47	3	6	6	3
Transportation & Ordinance	19	1	2	-	4
Instruments & Miscellaneous	11	-	3	1	-

GRID COORDINATE SYSTEM

Grid coordinates based on the Universal Transverse Mercator System were used in this study to show the geographical distribution of sources and emissions. As shown in Figure 3, the Study Area was divided into 49 grids of three different sizes - 25,100 and 400 square kilometers.

Different size grids are used to limit the number of grid zones and yet allow a satisfactory definition of geographical gradation of emissions in areas where the majority of pollution occurs. For this reason, the 25 kilometer grids are used in the downtown areas where the emission densitites should change abruptly within short distances. In areas primarily rural in nature, the use of small zones are not as important.

As illustrated in Figure 3, each grid line is identified by a coordinate number. The north-south and the east-west coordinates are expressed in meters.

The point sources in the Study Area are identified by both horizontal and vertical coordinates to the nearest 100 meters. The grids are identified by the coordinates of their geographical center.

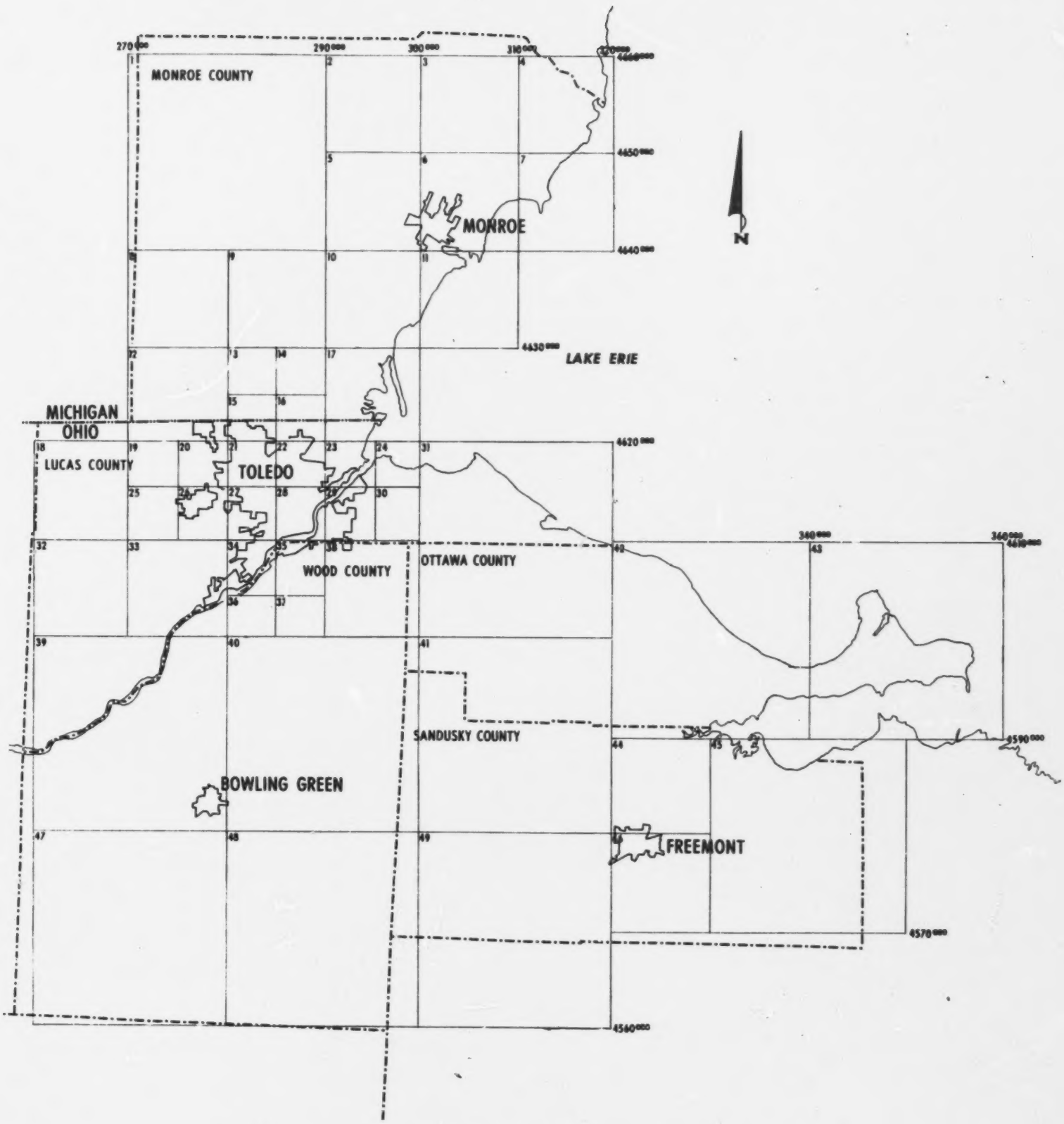

Figure 3. Grid coordinate system for the Toledo study area.

EMISSIONS BY CATEGORY

For the purposes of compiling the basic data and emission estimates, the air pollutant sources were classified into the following four categories:

1. Fuel combustion in stationary sources
2. Transportation
3. Solid-waste disposal
4. Industrial process losses

Each of these categories are considered individually in this section where data sources are given and methods of calculation are discussed.

It is important to note that the estimates presented herein and especially in the process loss category are, in most cases, partial totals. This stems from the inavailability of emission factors as well as appropriate production data. In the case of hydrocarbon emissions where gasoline evaporation was included but solvent evaporation was not, the totals are considerably lower than actual values. The results should be viewed with these limitations in mind.

Fuel Combustion in Stationary Sources

Although all of the three major fuels are consumed within the Study Area, coal is the most significant. As shown in Tables 4 - 6, approximately 3.1 million tons of coal, 5.3 million barrels of oil, and 118 billion cubic feet of natural gas were consumed in the Study Area. The breakdown of fuel consumption by user category and by jurisdiction is also shown in these tables.

The three steam-electric generating plants within the Study Area consumed 75 percent of the total coal utilized by all sources. Industry is the other prime user of coal consuming 19 percent of the total.

Distillate fuel oil is consumed mainly in residential heating purposes. Residual fuel oil is consumed almost entirely in industrial operations with a small portion of the total used by commercial and institutional establishments.

Industrial sources consume 58 percent of the natural gas in the Study Area; residential heating 31 percent and commercial and institutional 9 percent. The natural gas consumed by steam-electric plants is very small.

Average values for the sulfur and ash contents of the fuel used are summarized in Table 7.[4,5]

Emissions from Fuel Combustion

Air pollutant emissions resulting from fuel combustion in stationary sources are listed in Table 8. The emissions are presented for industrial, steam-electric utility, residential, and commercial and institutional sources.

Coal accounts for approximately 94 percent of the sulfur oxides emitted from fuel combustion in stationary sources; 94 percent of the particulates 96 percent of the carbon monoxide, 85 percent of the hydrocarbons and 67 percent of the nitrogen oxides.

The emissions resulting from the combustion of fuel oil and natural gas are minor compared to that from coal combustion.

Data Sources

Fuel consumption data for the Study Area were obtained from diverse sources. Natural gas numbers were obtained from the Columbia Gas Company of Ohio and Michigan Gas Utilities. They were provided on a county basis with a breakdown by industry, residential, commercial and institutional source category.

Coal consumption data in the five county area was obtained mainly from the individual point sources. Residential coal by county was estimated from the number of dwelling units using coal and the total number of degree days for the area. This method is described in detail in the Rapid Survey Technique.[6]

Oil consumption was gotten in much the same manner as coal. An emission survey already completed by Toledo was also used.

Transportation

Three types of transportation sources of air pollution are considered in this survey - road vehicles, aircraft, and vessels. Road vehicles, which are by far the most significant soure of air pollution in this category, are further subdivided according to type of fuel - gasoline and diesel.

Road Vehicles

The miles of travel by motor vehicles in the Study Area are summarized in Table 9. The major portion of the data for the City of Toledo was gotten from the data in the earlier emission survey. The rest of the Study Area had very little accurate vehicle-mileage data, so the gasoline consumption of each county was distributed by population.

Travel by diesel powered vehicles was estimated from statewide diesel fuel consumption figures. It was found that approximately 2.8 percent of the vehicle miles in the Area is diesel. Vehicle miles by diesel were also proportioned by population.

Aircraft

Table 11 shows the air traffic activity at the Toledo airport. The total aircraft operations were supplied by the Federal Aviation Administration. An operation is defined as either a take-off or a landing. Aircraft account for less than 5 percent of the total transportation emissions for any pollutant.

Solid Waste Disposal

Approximately 680,000 tons of refuse were generated during 1967 in the Study Area. Table 13 presents a solid waste balance for the Toledo Study Area, showing the various methods of disposal and the quantities disposed of by each method. Landfills accounted for 44 percent; on-site incineration 7 percent; dumps 26 percent; and on-site open burning 22 percent of the total refuse disposed.

Refuse data for Lucas, Wood, Ottawa and Sandusky County was supplied partially by the Ohio Department of Health and partially by the previous emission study. Information on the County of Monroe was gathered by City of Monroe officials.

Table 14 shows the air pollutant emissions from solid waste disposal in the Toledo Study Area. A total of 15,000 tons of carbon monoxide, 2,900 tons of particulates, and 1,900 tons of nitrogen oxides were emitted from solid waste disposal practices.

Industrial Process Losses

Table 15 shows the emission losses due to industrial process. All of these emissions were gathered from data on individual sources, and most are point sources within this survey.

TABLE 4. SUMMARY OF COAL CONSUMPTION IN TOLEDO-MONROE STUDY AREA, 1967 (TONS/YEAR)

	Residential	Commercial	Industrial	Steam Electric	Total
Lucas County	8,000	6,000	265,000	1,470,000	1,749,000
Ottawa County	10,000	4,000	--	--	14,000
Sandusky County	15,000	8,000	--	--	23,000
Wood County	12,000	6,000	--	--	18,000
Monroe County	38,000	21,000	325,000	940,000	1,324,000
TOTAL	83,000	45,000	590,000	2,410,000	3,128,000

TABLE 5. SUMMARY OF FUEL OIL CONSUMPTION IN TOLEDO-MONROE STUDY AREA, 1967 (BBL/YEAR)

	Residential	Commercial	Industrial	Steam Electric	Total
Lucas County	750,000	600,000	1,800,000	--	3,150,000
Ottawa County	200,000	100,000	150,000	--	450,000
Sandusky County	150,000	80,000	300,000	--	530,000
Wood County	400,000	150,000	200,000	--	750,000
Monroe County	250,000	140,000	50,000	--	440,000
TOTAL	1,750,000	1,070,000	2,500,000	--	5,320,000

TABLE 6. SUMMARY OF NATURAL GAS CONSUMPTION IN TOLEDO-MONROE STUDY AREA (10^6 cu. ft./Year)

	Residential	Commercial	Industrial	Steam Electric	Total
Lucas County	26,400	7,200	54,000	2,800	90,400
Ottawa County	1,300	400	2,500	--	4,200
Sandusky County	3,400	1,000	3,000	--	7,400
Wood County	3,000	1,200	7,000	--	11,200
Monroe	3,100	700	1,500	--	5,300
TOTAL	37,200	10,500	68,000	2,800	118,500

TABLE 7. CHEMICAL ANALYSIS OF FUELS BURNED IN TOLEDO-MONROE STUDY AREA

	Percent Sulfur	Percent Ash	Percent Volatile
Coal	2.9	9.1	38.1
Residual Fuel Oil	1.36		
Distillate Fuel Oil	.12		
Natural Gas	0.0008		

TABLE 8. SUMMARY OF EMISSIONS FROM BURNING OF FUELS IN STATIONARY SOURCES, 1967 (TONS/YEAR)

	User Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Coal	Industrial	32,800	21,700	900	300	5,900
	Steam-Electric	123,400	16,000	600	200	24,100
	Residential	4,500	700	2,000	400	400
	Commercial	2,500	1,000	1,100	200	100
	Totals	163,200	39,400	4,600	1,100	30,500
Fuel Oil	Industrial	9,800	1,100	100	100	3,700
	Steam-Electric	--	--	--	--	--
	Residential	700	300	100	100	500
	Commercial	200	200	Neg.	Neg.	800
	Totals	10,700	1,600	200	200	5,000
Gas*	Industrial	22,000	1,000	Neg.	500	10,600
	Steam-Electric	Neg.	Neg.	Neg.	Neg.	500
	Residential	Neg.	300	Neg.	Neg.	2,100
	Commercial	Neg.	100	Neg.	Neg.	600
	Totals	22,000	1,400	Neg.	500	13,800
GRAND TOTALS		195,900	42,400	4,800	1,800	49,300

*Includes high sulfur gas burned by refineries.

TABLE 9. VEHICLE-MILES TRAVEL IN TOLEDO-MONROE STUDY AREA, 1967 (10^3 Vehicle Miles/Day)

Political Jurisdiction	Gasoline Powered	Diesel Powered
Lucas County	4,980	140
Ottawa County	360	10
Sandusky County	720	20
Wood County	720	20
Monroe County	880	25
Total	7,660	215

TABLE 10. GASOLINE AND DIESEL CONSUMPTION IN TOLEDO-MONROE STUDY AREA, 1967 (10^6 gal./year)

Jurisdiction	Gasoline Consumption	Diesel Consumption
Lucas County	145	10.2
Ottawa County	10	.7
Sandusky County	21	1.4
Wood County	21	1.4
Monroe County	26	1.8
Total	223	15.5

TABLE 11. AIR ACTIVITY AT TOLEDO AIRPORT, 1967

	Itinerant Operations	Local Operations
Air Carrier	21,487	--
General Aviation	75,687	44,284
Military	6,625	9,826
Total	103,799	54,110

TABLE 12. SUMMARY OF TRANSPORATION EMISSIONS IN MONROE-TOLEDO STUDY AREA, 1967

(Tons/Year)

	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Road Vehicles	1,150	1,990	233,670	30,370	13,620
Gasoline	840	1,120	233,200	29,300	11,870
Diesel	310	870	470	1,070	1,750
Aircraft		90	4,050	890	250
Jet		80	130	160	70
Piston		10	3,920	730	180
Vessels	560	110	20	10	190
Totals	1,710	2,190	237,740	31,270	14,060

TABLE 13. REFUSE BALANCE FOR THE TOLEDO-MONROE STUDY AREA, 1967

(TONS/YEAR)

Jurisdiction	Generated	Incineration		Landfills	Dumps	On-Site Burning	Transferred
		Muncipal	On-Site				
Lucas County	470,000		50,000	160,000	60,000	70,000	130,000 (out)
Ottawa County	40,000				20,000	20,000	
Sandusky County	60,000				40,000	20,000	
Wood County	80,000				50,000	30,000	
Monroe County	30,000			140,000	10,000	10,000	130,000 (in)
TOTAL	680,000		50,000	300,000	180,000	150,000	

TABLE 14. AIR POLLUTANT EMISSIONS FROM SOLID WASTE DISPOSAL IN TOLEDO-MONROE STUDY AREA, 1967

(Tons/Year)

	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Total Incineration	100	300	1,100	Neg.	100
Muncipal					
On-Site	100	300	1,100	Neg.	100
Total Open Burning		2,600[1]	14,050	850	1,800
Dumps		1,400	7,650	450	1,000
On-Site		1,200	6,400	400	800
TOTAL EMISSIONS	100	2,900	15,150	15,850	1,900

TABLE 15. AIR POLLUTANT EMISSIONS FROM PROCESS EMISSION SOURCES IN TOLEDO-MONROE STUDY AREA, 1967 (Tons/Year)

	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Chemical				3,800	1,400
Petroleum Refining	15,500	1,900	42,900	30,700	2,100
Agricultural Products		6,000			
Cement Production		29,900			
Primary Metal Operations	1,400	800		2,300	300
Other		800		7,000	
Total	16,900	39,400	42,900	43,800	3,800

EMISSIONS BY JURISDICTION

In order to decide the relative significance between jurisdictions from an air pollution standpoint, emissions for each of the five jurisdictions have been summarized. Table 16 through Table 20 present the summary of each of these jurisdictions.

TABLE 16. SUMMARY OF AIR POLLUTANT EMISSIONS FOR LUCAS COUNTY
1967 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation	1,300	1,500	156,000	20,700	9,300
Road Vehicles	750	1,300	152,000	12,150	8,850
Evaporation				7,650	
Other	550	200	4,000	900	450
Combustion of Fuels by Stationary Sources	114,600	8,600	1,300	1,000	33,100
Industry	43,900	5,600	500	700	15,400
Steam-Electric	69,700	2,400	400	200	15,200
Residential	500	300	200	50	1,600
Commercial	500	300	200	50	900
Refuse Disposal	100	1,300	6,600	300	800
Incineration	100	300	1,100	Neg.	100
Open Burning		1,000	5,500	300	700
Industrial Process Emissions	16,900	26,400	42,900	43,800	3,800
Total Emissions	132,900	37,800	206,800	65,800	47,000

TABLE 17. SUMMARY OF AIR POLLUTANT EMISSIONS FOR OTTAWA COUNTY, 1967 (TONS/YEAR)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbon	Nitrogen Oxides
Transportation	50	100	10,900	1,400	650
Road Vehicles	50	100	10,900	850	650
Evaporation				550	
Other					
Combustion of Fuels by Stationary Sources	1,400	350	350	50	750
Industry	550	100	Neg.	Neg.	500
Steam-Electric					
Residential	600	150	250	50	150
Commercial	250	100	100	Neg.	100
Refuse Disposal		300	1,700	100	200
Incineration					
Open Burning		300	1,700	100	200
Industrial Process Emissions					
Total Emissions	1,450	750	12,950	1,550	1,600

TABLE 18. SUMMARY OF AIR POLLUTANT EMISSIONS FOR SANDUSKY COUNTY, 1967 (TONS/YEAR)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbon	Nitrogen Oxides
Transportation	100	200	21,900	2,850	1,200
Road Vehicles	100	200	21,900	1,750	1,200
Evaporation				1,100	
Other					
Combustion of Fuels By Stationary Sources	2,350	500	600	150	950
Industry	1,000	100	Neg.	Neg.	500
Steam-Electric					
Residential	900	200	400	100	300
Commercial	450	200	200	50	150
Refuse Disposal		500	2,550	150	350
Incineration					
Open Burning		500	2,550	150	350
Industrial Process Emissions					
Total Emissions	2,450	1,200	25,050	3,150	2,500

TABLE 19. SUMMARY OF AIR POLLUTANT EMISSIONS FOR WOOD COUNTY, 1967 (TONS/YEAR)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbon	Nitrogen Oxides
Transportation	100	200	21,900	2,850	1,300
Road Vehicles	100	200	21,900	1,750	1,300
Evaporation				1,100	
Other					
Combustion of Fuels By Stationary Sources	1,950	500	450	150	800
Industry	800	150	Neg.	Neg.	300
Steam-Electric					
Residential	800	200	300	100	300
Commercial	350	150	150	50	200
Refuse Disposal		650	3,350	250	450
Incineration					
Open Burning		650	3,350	250	450
Industrial Process Emissions					
Total Emissions	2,050	1,350	25,700	3,250	2,550

TABLE 20. SUMMARY OF AIR POLLUTANT EMISSIONS FOR MONROE COUNTY, 1967 (TONS/YEAR)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbon	Nitrogen Oxides
Transportation	150	200	26,700	3,500	1,550
Road Vehicles	150	200	26,700	2,150	1,550
Evaporation				1,350	
Other					
Combustion of Fuels by Stationary Sources	80,550	33,400	4,300	1,150	14,450
Industry	18,100	17,700	500	200	3,200
Steam-Electric	53,700	13,600	200	100	9,400
Residential	7,600	1,600	3,100	750	1,650
Commercial	1,150	500	500	100	200
Refuse Disposal		150	850	50	100
Incineration					
Open Burning		150	850	50	100
Industrial Process Emissions		13,000			
Total Emissions	80,700	46,750	31,850	4,700	16,100

EMISSIONS BY GRID

For the purpose of modeling the air pollutant emissions in the Study Area, the resulting emissions were apportioned on the grid reference system shown in Figure 3.

The emissions of each pollutant were divided into two source subgroups--point and area sources. The 37 point sources were identified by source category, grid numbers and horizontal and vertical coordinates. Figure 4 shows the approximate location of major point sources in the Study Area. The point sources are presented in Table 21, along with the emissions for the five pollutants for an average annual, winter and summer day.

The emissions for all sources on the annual, winter and summer basis are shown in Table 22. These emissions are the total of all area and point sources for each grid.

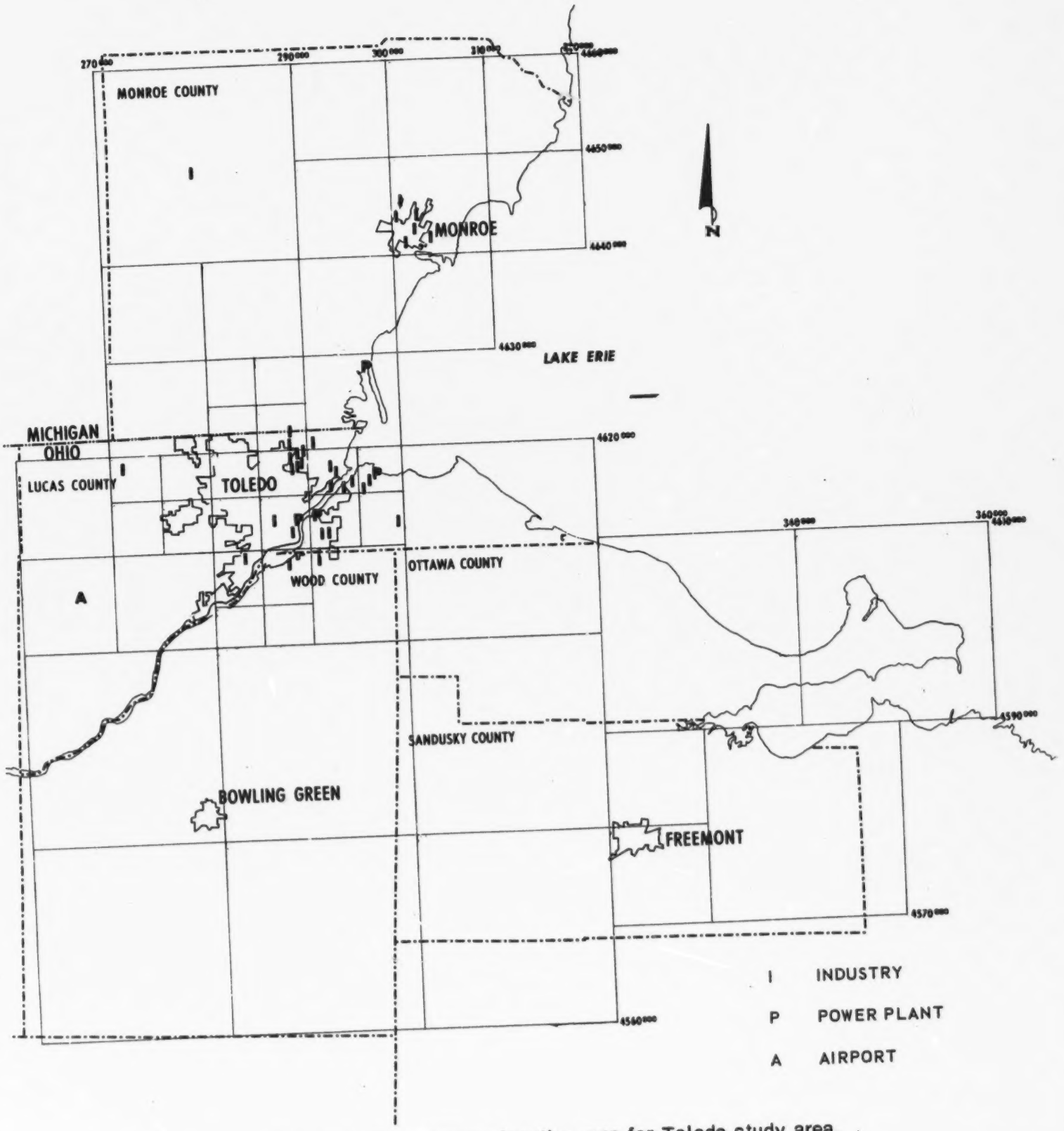

Figure 4. Point source location map for Toledo study area.

TABLE 21. SUMMARY OF EMISSIONS FROM POINT SOURCES IN THE TOLEDO STUDY AREA (TONS/DAY)

Source Category	Grid	Hor. Coor. (100m)	Vert. Coor. (100m)	SO_x SUM	SO_x WIN	SO_x AVG	PART. SUM	PART. WIN	PART. AVG	CO SUM	CO WIN	CO AVG	HC SUM	HC WIN	HC AVG	NO_x SUM	NO_x WIN	NO_x AVG
Industry	6	3040	46420	5.72	6.65	6.36	6.02	7.01	6.69	0.16	0.18	0.17	0.05	0.06	0.06	1.04	1.21	1.15
Industry	6	3010	46460	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
Industry	6	3030	46425	38.15	44.36	42.38	40.16	46.71	44.62	1.04	1.21	1.15	0.35	0.40	0.38	6.92	8.05	7.69
Industry	6	3025	46435	0.00	20.28	12.40	0.00	21.35	13.05	0.00	0.55	0.34	0.00	0.18	0.11	0.00	3.68	2.25
Industry	6	3005	46445	5.72	6.65	6.36	1.61	1.87	1.78	0.16	0.18	0.17	0.05	0.06	0.06	1.04	1.21	1.15
Industry	16	2860	46220	1.11	1.29	1.23	0.73	0.85	0.82	0.03	0.04	0.03	0.01	0.01	0.01	0.36	0.42	0.40
Industry	16	2860	46205	0.25	0.30	0.28	0.05	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.20	0.18
Power Plant	17	2970	46295	149.15	149.15	147.11	37.68	37.68	37.16	0.65	0.65	0.65	0.26	0.26	0.26	26.17	26.17	25.81
Industry	22	2890	46195	0.00	0.00	0.00	0.01	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.06	0.06
Industry	22	2875	46190	0.15	0.46	0.31	0.04	0.11	0.07	0.00	0.01	0.01	0.27	0.28	0.27	0.19	0.58	0.39
Industry	22	2870	46175	3.63	11.31	9.08	0.98	3.04	2.44	0.10	0.31	0.25	3.67	3.74	3.72	0.69	2.14	1.71
Industry	23	2905	46160	0.00	0.00	0.00	0.04	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.57	0.51
Industry	23	2930	46165	25.08	25.08	25.08	1.09	1.09	1.09	0.06	0.06	0.06	10.97	10.97	10.97	3.74	3.74	3.74
Industry	23	2910	46165	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.03
Power Plant	24	2970	46180	151.70	151.70	143.87	2.81	2.81	2.67	0.80	0.80	0.76	0.32	0.32	0.30	31.94	31.94	30.29
Industry	24	2960	46175	6.43	6.43	6.43	1.89	1.89	1.89	87.70	87.70	87.70	14.00	14.00	14.00	2.42	2.42	2.42

TABLE 21. SUMMARY OF EMISSIONS FROM POINT SOURCES IN THE TOLEDO STUDY AREA (TONS/DAY)

Source Category	Grid	Hor. Coor. (100m)	Vert. Coor. (100m)	SO_x SUM	SO_x WIN	SO_x AVG	PART. SUM	PART. WIN	PART. AVG	CO SUM	CO WIN	CO AVG	HC SUM	HC WIN	HC AVG	NO_x SUM	NO_x WIN	NO_x AVG
Industry	24	2955	46170	68.50	68.50	68.50	1.35	1.35	1.35	0.01	0.01	0.01	30.59	30.59	30.59	9.53	9.53	9.53
Power Plant	28	2890	46135	0.88	0.88	0.86	0.36	0.36	0.35	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.99
Industry	28	2885	46125	0.07	0.07	0.07	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.04
Power Plant	29	2905	46140	31.85	43.09	46.20	2.53	3.42	3.66	0.17	0.23	0.24	0.07	0.09	0.10	7.17	9.70	10.40
Industry	29	2915	46120	17.65	17.65	17.65	4.48	4.48	4.48	29.89	29.89	29.89	29.97	29.97	29.97	6.43	6.43	6.43
Industry	29	2915	46128	0.40	0.47	0.45	0.04	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.15	0.14
Industry	34	2825	46095	4.03	4.03	4.03	2.62	2.62	2.62	0.11	0.11	0.11	3.59	3.59	3.59	0.82	0.82	0.82
Industry	35	2870	46100	18.71	22.76	20.79	2.36	2.87	2.63	0.49	0.60	0.55	0.16	0.20	0.18	3.28	3.99	3.65
Industry	38	2910	46100	10.11	11.01	10.64	5.02	5.47	5.29	0.27	0.29	0.28	0.09	0.10	0.09	2.46	2.68	2.59
Industry	22	2895	46195	0.00	0.00	0.00	0.00	0.00	0.00	3.90	3.90	3.90	0.60	0.60	0.60	0.00	0.00	0.00
Industry	22	2895	46180	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.54	15.54	15.54	0.00	0.00	0.00
Industry	28	2865	46130	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	6.00	6.00	0.00	0.00	0.00
Industry	17	2905	46205	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.21	2.21	2.21	0.00	0.00	0.00
Industry	22	2890	46190	0.00	0.00	0.00	15.00	15.00	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry	30	2995	45125	0.00	0.00	0.00	1.40	1.40	1.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry	19	2715	46185	0.00	0.00	0.00	47.26	47.26	47.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Airport	32	2660	46070	0.00	0.00	0.00	0.25	0.25	0.25	11.10	11.10	11.10	2.43	2.43	2.43	0.70	0.70	0.70

TABLE 21. SUMMARY OF EMISSIONS FROM POINT SOURCES IN THE TOLEDO STUDY AREA (TONS/DAY)

Source Category	Grid	Hor. Coor. (100m)	Vert. Coor. (100m)	SUM	WIN	AVG	SUM	WIN	AVG	SUM	WIN	AVG	SUM	WIN	AVG	SUM	WIN	AVG
Industry	23	2930	46160	0.00	0.00	0.00	1.06	1.06	1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry	1	2790	46495	0.00	0.00	0.00	34.66	34.66	34.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry	6	3010	46415	0.00	0.00	0.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Industry	23	2925	46160	3.77,	3.77	3.77	2.19	2.19	2.19	0.08	0.08	0.08	0.17	0.17	0.17	0.87	0.87	0.87

TABLE 22. EMISSIONS FROM TOTAL SOURCES IN TOLEDO STUDY AREA BY GRID

(TONS/DAY)

Grid	Hor. Coor. (100m)	Vert. Coor (100m)	(mi^2)	SUM	SO_x WIN	AVG	SUM	PART. WIN	AVG	SUM	CO WIN	AVG	SUM	HC WIN	AVG	SUM	NO_x WIN	AVG
1	2800	46500	154.40	0.05	0.27	0.15	34.78	34.88	34.87	9.76	8.79	9.23	1.25	1.15	1.19	0.60	0.80	0.69
2	2950	46550	38.60	0.01	0.06	0.03	0.03	0.05	0.04	2.42	2.18	2.29	0.30	0.28	0.29	0.15	0.20	0.17
3	3050	46550	38.60	0.03	0.15	0.09	0.07	0.13	0.09	5.74	5.17	5.43	0.74	0.68	0.71	0.34	0.46	0.40
4	3150	46550	38.60	0.01	0.08	0.05	0.03	0.07	0.05	3.11	2.81	2.95	0.39	0.36	0.37	0.19	0.25	0.22
5	2950	46450	38.60	0.46	2.95	1.67	0.32	0.77	0.54	7.71	8.01	7.81	1.01	1.15	1.07	1.19	1.49	1.34
6	3050	46450	38.60	50.86	87.83	72.98	48.66	79.58	68.95	24.66	26.76	25.66	3.48	4.27	3.88	12.56	19.67	16.79
7	3150	46450	38.60	0.00	0.01	0.00	0.00	0.00	0.00	0.50	0.45	0.48	0.06	0.06	0.06	0.02	0.04	0.03
8	2750	46350	38.60	0.00	0.04	0.02	0.02	0.04	0.03	1.61	1.45	1.52	0.20	0.19	0.19	0.09	0.12	0.11
9	2850	46350	38.60	0.03	0.16	0.09	0.07	0.13	0.10	6.00	5.40	5.67	0.77	0.71	0.74	0.37	0.49	0.42
10	2950	46350	38.60	0.05	2.30	1.14	0.08	0.49	0.28	6.90	7.17	6.99	0.89	1.01	0.94	0.42	0.67	0.54
11	3050	46350	38.60	0.00	0.02	0.01	0.00	0.01	0.01	1.00	0.90	0.95	0.12	0.11	0.12	0.05	0.07	0.06
12	2750	46250	38.60	0.15	0.21	0.18	0.35	0.43	0.39	32.02	28.76	30.24	4.13	3.71	3.90	1.93	2.26	2.08
13	2825	46275	9.65	0.02	0.14	0.08	0.06	0.11	0.09	5.12	4.61	4.84	0.66	0.61	0.63	0.30	0.41	0.35
14	2875	46275	9.65	0.01	0.07	0.04	0.03	0.06	0.04	2.65	2.39	2.51	0.33	0.31	0.32	0.16	0.22	0.19
15	2825	46225	9.65	0.18	0.40	0.29	0.51	0.66	0.58	30.14	27.20	28.53	3.82	3.43	3.61	1.97	2.46	2.21
16	2875	46225	9.65	1.51	1.95	1.76	1.24	1.51	1.39	23.91	21.62	22.66	3.02	2.72	2.86	2.13	2.64	2.38
17	2950	46250	38.60	149.22	149.25	147.19	37.84	37.88	37.34	15 23	13.75	14.42	4.34	4.16	4.24	27.05	27.21	26.76
18	2650	46150	38.60	0.02	0.03	0.02	0.08	0.09	0.09	5.44	4.90	5.15	0.69	0.62	0.65	0.33	0.38	0.35

TABLE 22. EMISSIONS FROM TOTAL SOURCES IN TOLEDO STUDY AREA BY GRID

(TONS/DAY)

Grid	Hor. Coor. (100m)	Hor. Coor. (100m)	Area (mi^2)	SO_x SUM	SO_x WIN	SO_x AVG	PART. SUM	PART. WIN	PART. AVG	CO SUM	CO WIN	CO AVG	HC SUM	HC WIN	HC AVG	NO_x SUM	NO_x WIN	NO_x AVG
19	2725	46175	9.65	0.05	0.05	0.05	.14	.15	.14	8.55	7.70	8.08	1.08	0.97	1.02	0.53	0.61	0.56
20	2775	46175	9.65	0.10	0.29	0.20	0.27	0.38	0.33	16.21	14.65	15.35	2.06	1.86	1.95	1.11	1.45	1.28
21	2825	46175	9.65	0.49	1.23	0.86	0.91	1.22	1.07	42.92	39.00	40.77	5.39	4.90	5.12	3.46	4.48	3.97
22	2875	46175	9.65	4.39	13.24	10.41	17.13	19.62	18.80	67.62	61.83	64.47	28.18	27.49	27.82	5.37	8.30	7.12
23	2925	46175	9.65	31.23	31.72	31.49	5.33	5.53	5.42	31.12	28.18	29.51	14.11	14.73	14.91	8.65	9.35	9.02
24	2975	46175	9.65	227.47	227.47	219.61	6.17	6.19	6.03	88.63	91.19	89.86	47.39	45.28	45.24	44.07	45.46	43.84
25	2725	46125	9.65	0.02	0.02	0.02	0.08	0.09	0.08	5.13	4.62	4.85	0.65	0.58	0.61	0.31	0.36	0.33
26	2775	46125	9.65	0.07	0.26	0.17	0.18	0.28	0.23	10.45	9.47	9.91	1.33	1.20	1.26	0.75	1.05	0.90
27	2825	46125	9.65	0.20	0.76	0.48	0.63	0.86	0.74	32.96	29.93	31.29	4.15	3.77	3.94	2.18	2.87	2.51
28	2875	46125	9.65	1.87	2.65	2.27	1.41	1.71	1.55	49.52	44.89	46.98	12.26	11.67	11.93	5.32	6.31	5.81
29	2925	46125	9.65	50.73	62.36	65.29	7.65	8.71	8.87	60.76	57.83	59.20	33.98	33.59	30.76	15.95	19.05	19.38
30	2975	46125	9.65	0.03	0.03	0.03	1.46	1.47	1.45	6.96	6.25	6.57	0.89	0.80	0.84	0.41	0.41	0.41
31	3100	46100	154.40	0.06	0.14	0.10	0.19	0.24	0.22	11.83	10.66	11.19	1.49	1.35	1.42	0.73	0.87	0.80
32	2650	46050	38.60	.02	.03	.02	.68	.69	.69	27.77	27.21	27.46	5.55	5.48	5.51	1.74	1.79	1.76
33	2750	46050	38.60	0.66	0.94	0.81	.46	0.60	0.53	19.58	17.68	18.54	2.49	2.24	2.36	2.22	2.75	2.50
34	2825	46075	9.65	5.25	5.80	5.55	3.24	3.44	3.35	23.34	21.16	22.14	6.56	6.28	6.40	3.99	4.68	4.38
35	2875	46075	9.65	19.45	25.35	22.45	2.73	3.66	3.20	6.85	7.15	6.97	0.96	1.07	1.01	4.62	5.76	5.23

TABLE 22. EMISSIONS FROM TOTAL SOURCES IN TOLEDO STUDY AREA BY GRID
(TONS/DAY)

Grid	Hor. Coor. (100m)	Vert. Coor. (100m)		SO_x SUM	SO_x WIN	SO_x AVG	PART. SUM	PART. WIN	PART. AVG	CO SUM	CO WIN	CO AVG	HC SUM	HC WIN	HC AVG	NO_x SUM	NO_x WIN	NO_x AVG
36	2825	46025	9.65	0.76	3.72	2.22	0.53	1.15	0.83	11.56	11.77	11.60	1.44	1.56	1.49	1.70	2.26	2.01
37	2875	46025	9.65	0.05	0.46	0.25	0.05	0.21	0.13	0.68	0.80	0.74	0.09	0.11	0.10	0.10	0.25	0.19
38	2950	46050	38.60	10.56	11.64	11.19	5.37	5.88	5.68	8.58	7.86	8.18	1.13	1.05	1.08	3.59	4.02	3.84
39	2700	45900	154.40	0.77	1.45	1.13	0.67	0.95	0.81	16.23	14.95	15.53	2.02	1.88	1.94	2.02	2.52	2.29
40	2900	45900	154.40	0.07	0.26	0.16	0.47	0.57	0.52	15.08	13.73	14.34	1.86	1.71	1.77	1.04	1.26	1.14
41	3100	45900	154.40	0.46	0.66	0.57	0.53	0.63	0.59	17.60	15.97	16.71	2.18	1.99	2.07	1.45	1.72	1.59
42	3300	46000	154.40	1.12	4.70	2.90	0.83	1.54	1.18	15.62	15.77	15.61	1.84	2.00	1.91	1.95	2.55	2.26
43	3500	46000	154.40	1.07	1.68	1.40	2.76	2.97	2.87	22.10	21.41	21.71	1.87	1.84	1.85	2.96	3.33	3.17
44	3250	45850	38.60	1.76	4.74	3.16	0.72	1.48	1.08	17.60	17.24	17.32	2.21	2.25	2.22	1.90	2.52	2.22
45	3400	45800	154.40	1.11	1.92	1.43	0.63	1.05	0.83	17.58	16.27	16.84	2.20	2.05	2.12	1.59	2.05	1.83
46	3250	45750	38.60	1.38	4.18	2.77	0.69	1.19	0.94	20.98	20.15	20.46	2.59	2.58	2.57	1.38	1.77	1.56
47	2700	45700	154.40	0.03	0.12	0.07	0.22	0.27	0.24	7.16	6.51	6.81	0.87	0.80	0.83	0.49	0.60	.54
48	2900	45700	154.40	0.04	0.15	0.09	0.28	0.34	0.30	9.07	8.26	8.63	1.11	1.02	1.06	0.62	0.75	0.68
49	3100	45700	154.40	0.17	0.22	0.20	0.10	0.13	0.12	3.50	3.17	3.32	0.44	0.40	0.42	0.31	0.37	0.33

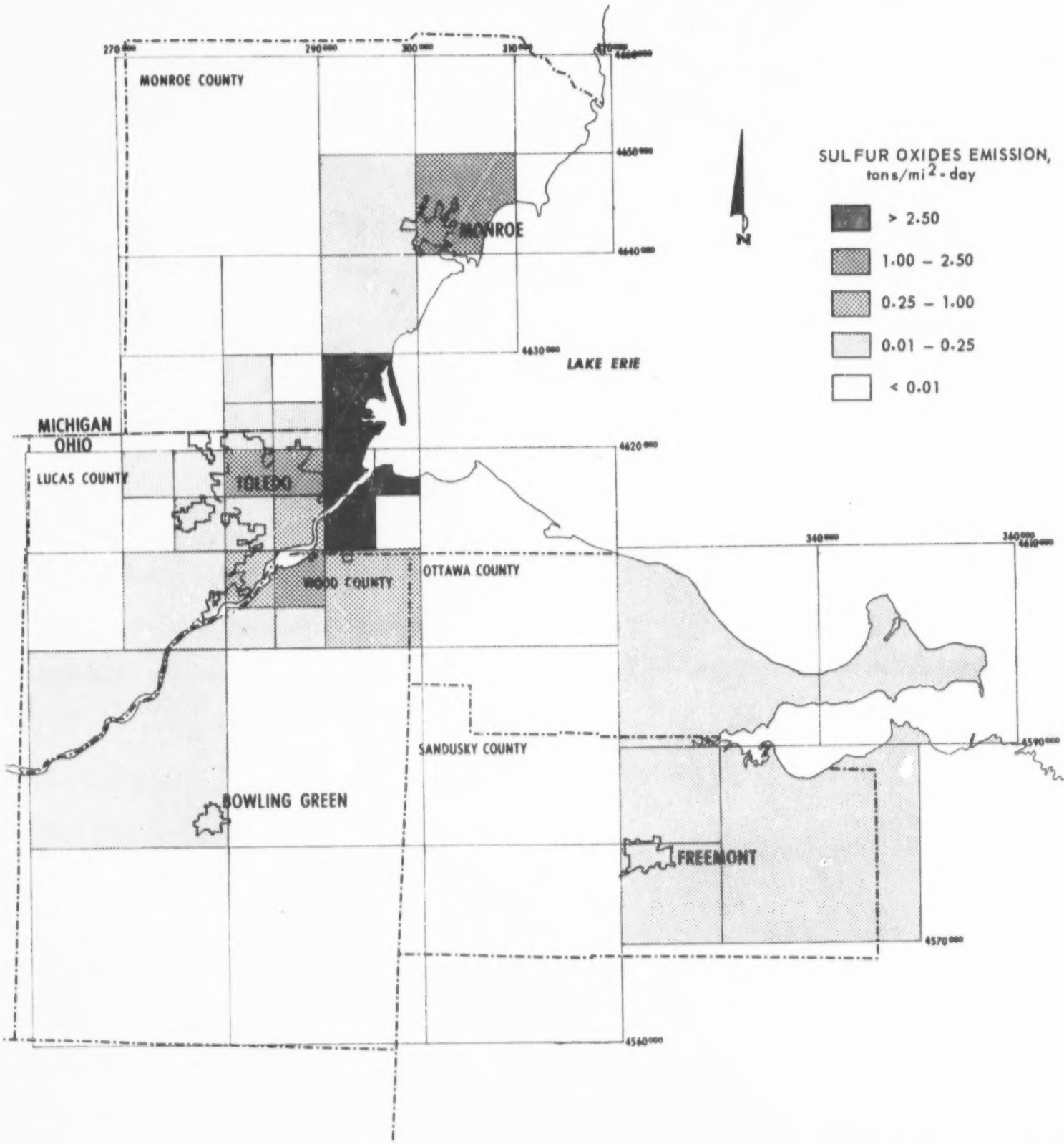

Figure 5. Sulfur oxide emission density from all sources for Toledo study area.

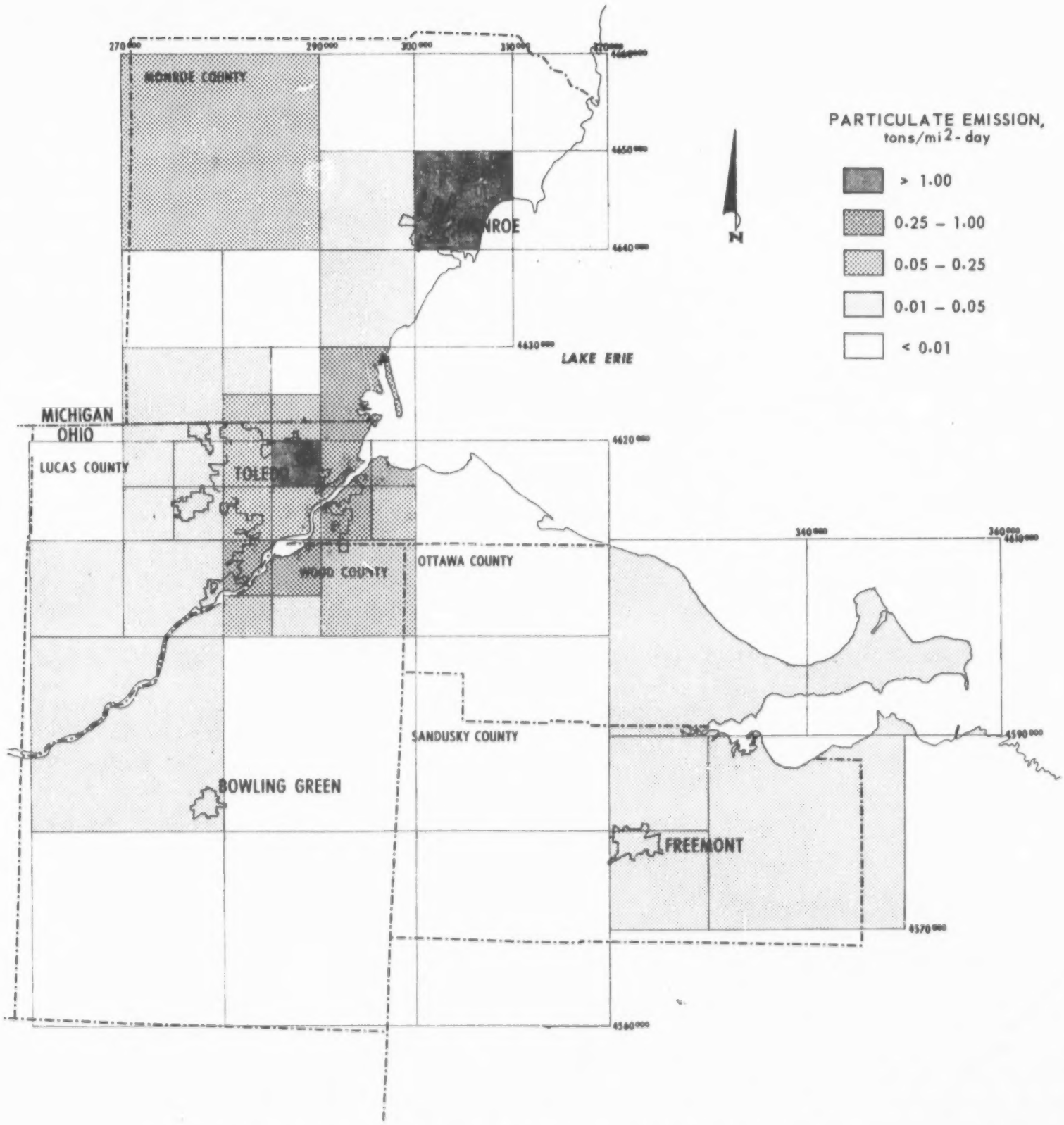

Figure 6. Particulate emission density from all sources for Toledo study area.

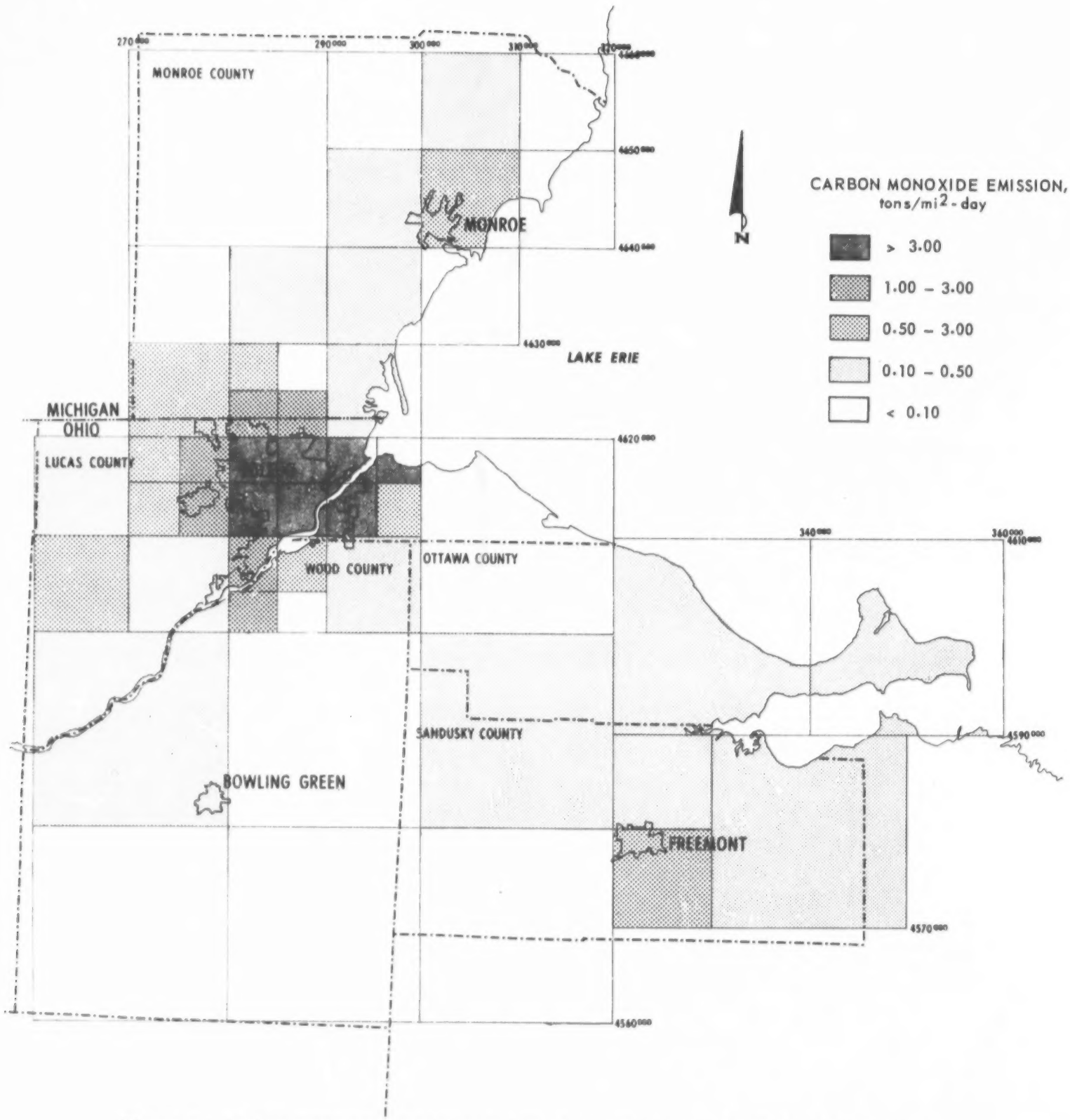

Figure 7. Carbon monoxide emission density from all sources for Toledo study area.

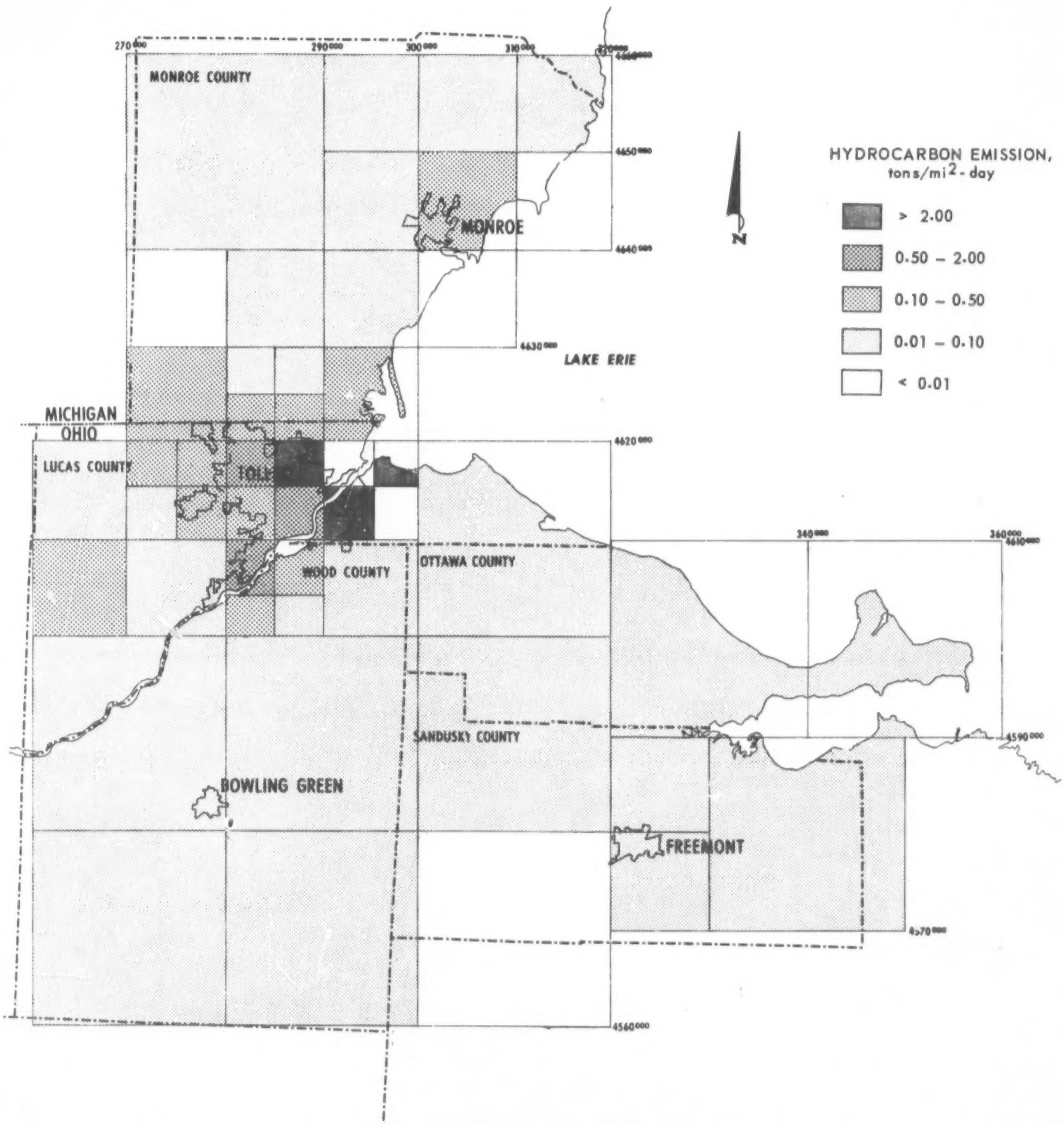

Figure 8. Hydrocarbon emission density from all sources for Toledo study area.

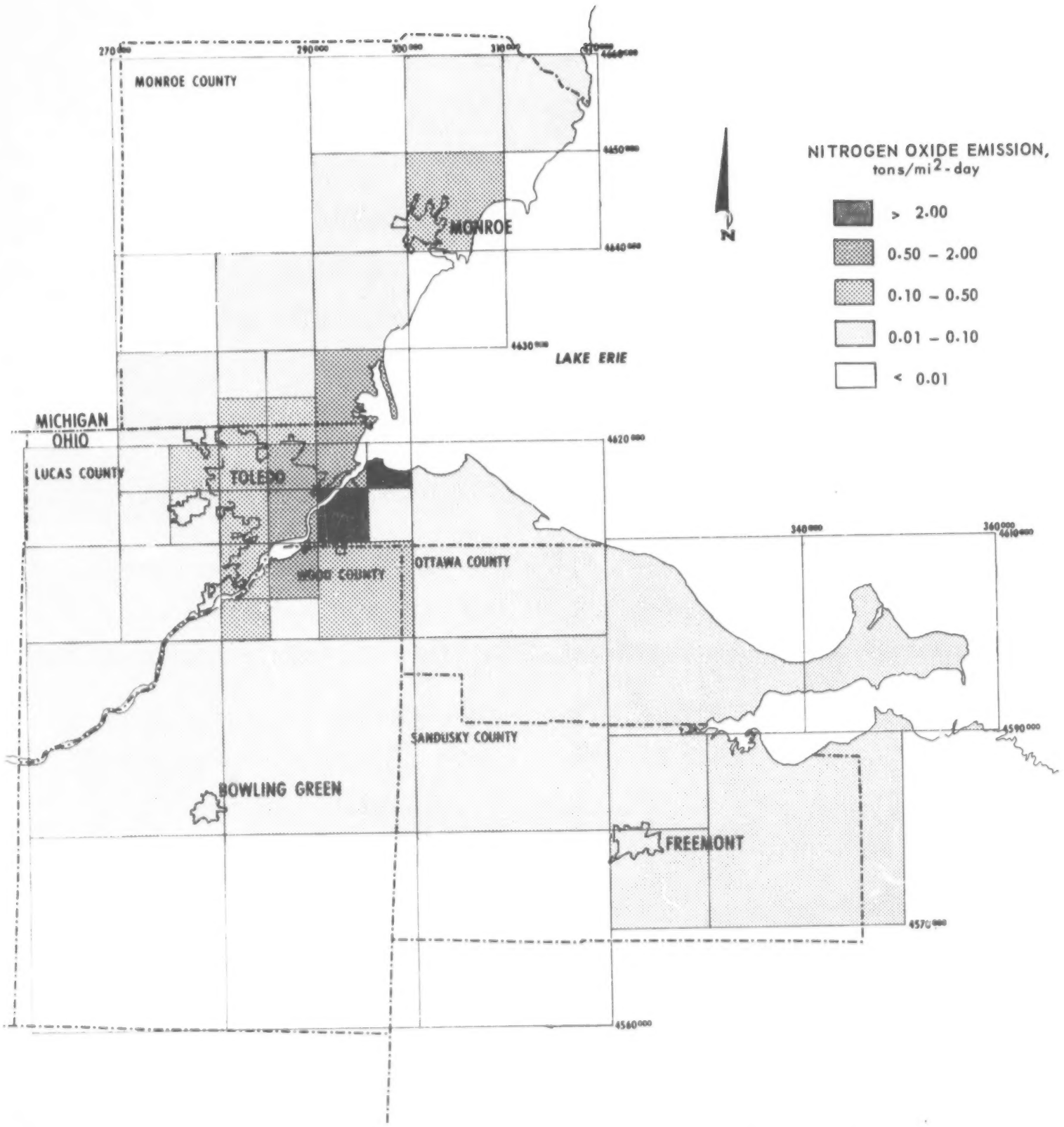

Figure 9. Nitrogen oxide emission density from all sources for Toledo study area.